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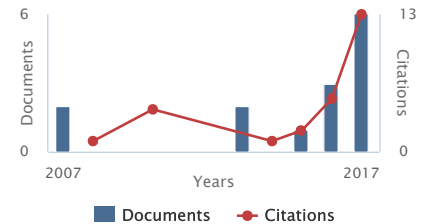
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Thermal image, partial discharge and leakage current correlation of ceramic insulator under different contamination level	Darwison,Arief, S., Abral, H.,(...), Ahmad, M.H.,Aulia	2017	ARPN Journal of Engineering and Applied Sciences	0
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Preliminary study on biogas production from POME by DBD plasma	Hazmi, A.,Desmiarti, R.,Emeraldi, P.,(...), Edwardo,Waldi, E.P.	2017	Telkomnika (Telecommunication Computing Electronics and Control)	0
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Research on positive narrow bipolar events in Padang	Hazmi, A.,Emeraldi, P., Hamid, M.I.,Takagi, N.	2017	Proceedings - 2016 3rd International Conference on Information Technology, Computer, and Electrical Engineering, ICITACEE 2016	0
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Characterization of positive cloud to ground flashes observed in Indonesia	Hazmi, A.,Emeraldi, P., Hamid, M.I.,Takagi, N., Wang, D.	2017	Atmosphere	1
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Observed electric field changes of positive lightning flashes preceded by preliminary breakdown in padang	Hazmi, A.,Desmiarti, R.,Emeraldi, P., Hamid, M.I.,Takagi, N.	2017	International Journal on Electrical Engineering and Informatics	0
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Preliminary study on treatment of palm oil mill effluent by sand filtration-dielectric barrier discharge system	Hazmi, A.,Desmiarti, R.,Waldi, E.P.,Emeraldi, P.	2016	Journal of Engineering and Technological Sciences	3
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Characteristics of electric field change preceding negative first return stroke produced by preliminary breakdown	Hazmi, A.,Hendri, Z.,Mulyadi, S.,(...),Wang, D.,Takagi, N.	2013	Proceedings - 2013 International Conference on Information Technology and Electrical Engineering: "Intelligent and Green Technologies for Sustainable Development", ICITEE 2013	4
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The leakage current analysis on 20 kV suspension porcelain insulator contaminated by salt moisture and cement dust in Padang area	Aulia,David, F.,Waldi, E.P.,Hazmi, H.	2007	Proceedings of the IEEE International Conference on Properties and Applications of Dielectric Materials	5
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October 19th – 21st, 2016 at @HOM Hotel, Semarang, INDONESIA

ICITACEE 2016 Conference Technical Program Overview

A1. Electric & Power System (Wednesday: October 19th, 2016. 12:30-14:45) LEXICON

No	Paper ID	Title	Authors
1	EPS-01	Investigation of Themperature Rise Considering the Stator Parameters in a High-Speed Spindle Motor	Wawan Purwanto, Jerry Chih Tsong Su
2	EPS-02	Voltage Balancing Circuits for Five-Level Power Inverter With A Single DC Voltage Source	Suroso, Abdullah Nur Aziz
3	EPS-03	The Use of Neural Network (NN) to Predict Voltage Drop during Starting of Medium Voltage Induction Motor	Fidelis Galla Limbong
4	EPS-04	Research on Positive Narrow Bipolar Events in Padang	Ariadi Hazmi, Primas Emeraldi, M. Imran Hamid, Nobuyaki Takagi
5	EPS-05	Minimization of Cogging Torque Based on Different Shape of Anti Notch Method	Herlina, Rudy Setiabudy, Uno Bintang Sudibyo
6	EPS-06	Investigation the Influence of Variation Number and different width of Anti Notch to Cogging Torque Reduction	Rudy Setiabudy, Herlina
7	EPS-07	Voltage Drop Simulation at Southern Sulawesi Power System Considering Composite Load Model	Ardiaty Arief, Muhammad Bachtiar Nappu
8	EPS-08	Analytical Design of Sea Wave Energy Power Plant Using Tubular Linear PM Generator in Southern Coast of Yogyakarta, Indonesia	Budi Azhari, Fransisco Danang Wijaya, Dewangga Adhyaksa, Wassy Prawinnetou
9	EPS-09	Reduction on Cogging Torque in Dual Stator Radial Flux Permanent Magnet Generator for Low Speed Wind Turbine	Adeguna Ridlo Pramurti, Eka Firmansyah, Suharyanto

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No	Paper ID	Title	Authors
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3	EPS-12	Discrimination of Particle-Initiated Defects in Gas-Insulated System Using C4.5 Algorithm	Firmansyah Nur Budiman, Elvira Sukma Wahyuni
4	EPS-13	Enhanced Fault Ride -Through Ability of DFIG-Based Wind Energy System Using Superconducting Fault Current Limiter	Chandan Kumar Sharma, Subhendu Sekhar Sahoo, Kalyan Chatterjee
5	EPS-14	Design of Photovoltaic BLDC Motor-Water Pump System with Single Converter	Slamet Riyadi
6	EPS-15	Integrated LC Resonant Converter and Silent Discharge Ozonizer for Colour Removal	Mochammad Facta, Hermawan, Zolkafle Buntat
7	EPS-17	A Prototype of Multistage Dynamic Braking of Three Phase Squirrel Cage Induction Motor	Tejo Sukmadi, Syauqie Candra Buana, Trias Andromeda, Mochammad Facta
8	EPS-18	Application of Dielectric Barrier Discharge Plasma for Reducing Chemical Oxygen Demand (COD) on Industrial Rubber Waste Treatment	Abdul Syakur, Badrus Zaman, Fauzan, Nur Jannah, Nurmaliakasih Dias Yunita

B1. Electronic Circuit & Control (Wednesday: October 19th, 2016. 12:30-14:45) OLIVETTI

No	Paper ID	Title	Authors
1	ECC-01	Human Tracking Application in a Certain Closed Area Using RFID Sensors and IP Camera	Daniel Patricko Hutabarat, Darma Patria, Santoso Budijono, Robby Saleh
2	ECC-02	Designing And Implementation Of Autonomous Quadrotor As Unmanned Aerial Vehicle	Felix Yustian Setiono, Anthony Candrasaputra, Tobias Bimo Prasetyo, Kho Lukas Budi Santoso
3	ECC-03	Multi Channel Electromyography (EMG) Signal Acquisition based Microcontroller	Florentinus Budi Setiawan, Siswanto
4	ECC-04	ECG Signal Processing using Offline-Wavelet Transform Method based on ECG-IoT Device	Amri Faizal, Muhammad Ilham R, and Arjon Turnip
5	ECC-06	Trans-impedance Amplifier (TIA) Design for Visible Light Communication (VLC) using Commercially Available OP-AMP	Syifaul Fuada, Angga Pratama, Trio Adiono, Yulian Aska

No	Paper ID	Title	Authors
6	ECC-07	Robot Arm Controlled By Muscle Tension Based On Electromyography And PIC18f4550	Ricky Fajar Adiputra, Florentinus Budi Setiawan
7	ECC-08	A Low Cost Anthropomorphic Prosthetic hand Using DC Micro Metal Gear motor	Mochammad Ariyanto, Munadi, Gunawan D. Haryadi, Rifky Ismail, Jonny A. Pakpahan, and Khusnul A. Mustaqim
8	ECC-09	New watershed segmentation algorithm based on hybrid gradient and self-adaptive marker extraction	Li Yuan, Yu Qingsong, Shen Chaomin, Hu Wenxin
9	ECC-10	Variations on Load and Distance Controller for Ropeless Elevator with Fuzzy	Ainil Syafitri, Iwa Garniwa MK, Iwa Garniwa MK, I Made Ardita
10	ECC-11	Fuzzy-PID Simulations on Ropeless Elevator Performance	Ainil Syafitri, Iwa Garniwa MK, Ridwan Gunawan, I Made Ardita
11	ECC-12	A Simple Proportional plus PD Sign for Asymptotically Stable Robot Manipulators	Adha Cahyadi, Samiadj Herdjunanto, Herianto
12	ECC-13	Arrival Time Field Based Path Planning Algorithm for Mobile Robot	Imaduddin A. Majid, Adha Imam Cahyadi, Igi Ardiyanto, and Muhammad Saifussalam

B2. Electronic Circuit & Control (Wednesday: October 19th, 2016. 15:15-17:30) OLIVETTI

No	Paper ID	Title	Authors
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2	ECC-15	Yuarm: A Low Cost Android Platform for Vision Based Manipulators Control	Sisdarmanto Adinandra, Dani Erfawan
3	ECC-16	Development of Unmanned Aerial Vehicle (UAV) Ornithopter with Wireless Radio Control	Farika T Putri, Mochammad Ariyanto, Ismoyo Haryanto, Moh. Arozi, Wahyu Caesarendra, M. Rizki Ibrahim Hanan
4	ECC-17	Comparison Methods of Edge Detection for USG Images	M. Khairudin, Dessy Irmawati
5	ECC-18	Ultrasonic Signal Denoising Based on Wavelet Haar Decomposition Level	Herlinawati, Umi Murdika, Grienda Elan, Titin Yulianti



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No	Paper ID	Title	Authors
6	ECC-19	Sliding Mode Control for Therapeutic Pool Model Control System	Munadi, Henry Kristianto, Mochammad Ariyanto, Ismoyo Haryanto, Hari Peni Julianti
7	ECC-20	Experiment of Networked Control System (NCS) Using Network Emulator	Indra Sakti, Dicky Rianto Prajitno
8	ECC-21	Brainwave-Controlled Applications with the Emotiv EPOC Using Support Vector Machine	Kha Hoang Ha, Vo Anh Kha, Dinh Quoc Hung
9	ECC-22	Development of Hovercraft Prototype with Stability Control System using PID Controller	Munawar A Riyadi, Lazyo Rahmando, Aris Triwiyatno
10	ECC-23	Design of Color Based Object Sorting Through Arm Manipulator with Inverse Kinematics Method	Sumardi, Lanang Febriramadhan, Aris Triwiyatno
11	ECC-24	Designing Internal-External Control Method for Delta Robot Prototype to Manipulate Non-Linear Movement Object	Aris Triwiyatno, Muhammad Fikko Fadjrimiratno, Sumardi
12	ECC-25	Real Time Classification of SSVEP Brain Activity with Adaptive Feedforward Neural Networks	Arjon Turnip, M. Ilham Rizgyawan, Dwi Esti K, Jasman Pardede, Sandi Yanyoan, Edi Mulyana
13	ECC-28	Fuzzy-Mamdani Inference System in Predicting the Correlation Between Learning Method, Discipline and Motivation with Student's Achievement	Juningtyastuti, Fransiskus Allan Gunawan

C1. Information & Computer Technologies (Wednesday: October 19th, 2016. 12:30-14:45) OLYMPIA

No	Paper ID	Title	Authors
1	ICT-01	Calculation of Phantom Volume for Computed Tomography (CT) Scan Images	Kusworo Adi, Catur Edi Widodo, Aris Sugiharto, Qidir Maulana B. S., Adi Pamungkas
2	ICT-02	Design and Development of Android-based Cloud ECG Monitoring System	Muhammad Ilham Rizqyawan, M. Faizal Amri, Rian Putra Pratama, Arjon Turnip
3	ICT-03	Designing Framework for Software Reuse Maturity Improvement	Bagus Setyawan Wijaya, Yudi Satria Gondokaryono



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5	ICT-05	Design Architecture Enterprise Service Bus to Support Multi-Tenant Client and Resource Provider	Taufik Sulaeman Puspanegara, Albarda
6	ICT-06	Data Envelopment Analysis - Analytic Hierarchy Process Method for Performance Evaluation Study Program	Ali Wedo Sarjono, Farikhin Farikhin, Catur Edi Widodo
7	ICT-07	Eating for physical rather than emotional: A Bayesian Belief Network Approach for Android-Based Intuitive Eating Measurement	Anggita Dian Cahyani, Meiliana, Widodo Budiharto
8	ICT-08	Detection of the Beef Quality Using Mobile-Based K-Mean Clustering Method	Oky Dwi Nurhidayati, Kusworo Adi, Sri Pujiyanto
9	ICT-09	English – Indonesian Phrase Translation using Recurrent Neural Network and ADJ Technique	Wenty Octoviani, Muhammad Fachrurrozi, Novi Yusliani
10	ICT-10	IT Adoption Strategy to Promote Batik Micro-Scale Industry in Central Java, Indonesia Strengthening Universities Role In Batik Micro-Scale Industry	Rinta Kridalukmana, Naili Farida, Hari Susanta Nugraha
11	ICT-11	The Study of Theory of Planned Behavior of Building Automation System in Industrial Sector	Shu-Chiang Lin , Jacky Chin
12	ICT-12	A Literature Review of Question Answering System using Named Entity Recognition	Rini Wongso, Meiliana, Derwin Suhartono
13	ICT-13	The Benefit the Web 2.0 Technologies in Higher Education: Student's Perspectives	Yohana Dewi Lulu Widyasari, Lukito Edi Nugroho, Adhistya Erna Permanasari

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2	ICT-15	Detection Plagiarism Documents On Indonesian Using Min-Hash And Synonym Recognition	Muhammad Badriansyah Putra



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4	ICT-17	Decision Support System For New Employee Recruitment Using Weighted Product Method	Dyna Marisa Khairina, Muhammad Reski Asrian , Heliza Rahmania Hatta
5	ICT-18	Ontology Model For Complementary Breastfeeding Recipes	Sari Widya Sihwi, Athiyah, Afrizal Doewes
6	ICT-19	Development of Conceptual Model in Understand The Role of Organizational Factor in KMS Acceptance	Hetty Rohayani, Setiawan Assegaff, Kurniabudi
7	ICT-20	Pattern Discovery of Indonesian Customers in an Online Shop: A Case of Fashion Online Shop	Rianto Rianto, Lukito Edi Nugroho, Paulus Insap Santosa
8	ICT-21	Traffic Sign Detection Based On HOG and PHOG Using Binary SVM And k-NN	Aris Sugiharto, Agus Harjoko
9	ICT-22	Utilization of Social Media in Livestock Product Marketing Group of Cattle	Kurniawan Teguh Martono, Cahya Setya Utama, Bambang Sulistiyanto, Merry Christiyanto
10	ICT-23	ST-DBSCAN Clustering Module in SpagoBI for Hotspots Distribution in Indonesia	Sarah Shanaz Shaztika , Rina Trisminingsih
11	ICT-24	CBE : Corpus Based of Emotion for Emotion Detection in Text Document	Fika Hastarita Rachman, Riyanarto Sarno, Chastine Fatichah
12	ICT-25	Evaluation of IT Governance to Support IT Operation Excellent Based on COBIT 4.1 at the PT Timah Tbk	Ibrahim Lammada, Lela Nurpulaela
13	ICT-26	Disclosing the Automation of Quality Assurance System of Higher Education (QAS-HE) in Indonesia Using DevOps Approach	Acep Taryana, Setiawan
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C3. Information & Computer Technologies (Wednesday: October 19th, 2016. 15:15-17:30) LETTERA

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2	ICT-29	Parameter Optimization Of Brown's And Holt's Double Exponential Smoothing Using Golden Section Method For Predicting Indonesian Crude Oil Price (ICP)	Nurrahim Dwi Saputra , Abdul Aziz, Bambang Harjito
3	ICT-30	The Analysis of Instagram Technology Adoption as Marketing Tools by Small Medium Enterprise	Bobby Iswandi, Trianggoro Wiradinata
4	ICT-31	Commodity Cluster Using Single System Image Based on Linux/Kerrighed for High-Performance Computing	Iwan Setiawan, Eko Murdyantoro
5	ICT-32	Noise Removal on Batak Toba Handwritten Script using Artificial Neural Network	Novie Theresia Br Pasaribu and M. Jimmy Hasugian
6	ICT-33	Shooting Simulator System Design Based Augmented Reality	Kurniawan Teguh Martono, Oky Dwi Nurhayati
7	ICT-34	Optimizing MySQL Database System on Information Systems Research , publications and Community Service	Kodrat Iman Satoto, R. Rizal Isnanto, Rinta Kridalukmana , Kurniawan Teguh Martono,
8	ICT-35	Information Technology Audit For Management Evaluation Using COBIT and IT Security	Assaf Arief, Iis Hamsir Ayub Wahab
9	ICT-36	Performance Comparisons of Web Server Load Balancing Algorithms on HAProxy and Heartbeat	Agung B. Prasetijo, Eko D. Widiyanto and Ersya T. Hidayatullah
10	ICT-37	Performance Analysis of MAC Protocol for Resource Sharing D2D and M2M in Unlicensed Channel	Aghus Sofwan
11	ICT-38	Mobile Cloud Computing Security Using Cryptographic Hash Function Algorithm	Muhammad Arfan
12	ICT-39	On The Implementation of ZFS (Zettabyte File System) Storage System	Eko D. Widiyanto, Agung B. Prasetijo, and Ahmad Ghufroni

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2	TRF-03	Implementation of Ultrasonic Communication for Wireless Body Area Network Using Amplitude Shift Keying Modulation	Muhammad Harry Bintang Pratama, Ajub Ajulian Zahra, Khusnil Mujib, Arif Munandar, Erizco Satya Wicaksono
3	TRF-04	Energy Efficiency Beamformers for K-User MIMO Interference Channels with Interference Alignment	Ha Hoang Kha, Tuan Do-Hong
4	TRF-05	Cyclic Prefix-based Noise Estimation with DVB-T Input for Spectrum Sensing in Cognitive Radio	Dzata Farahiyah, Trung Thanh Nguyen, Thomas Kaiser
5	TRF-06	Path Loss Model Estimation Based on Measurements of Off-Body and On-Body Communication Using Textile Antenna at 2.45 GHz	Basari, Novi Yohanna , Ria Aprilliyani, Rian Gilang Prabowo
6	TRF-07	Signal Analysis of GMSK Modulation-based CubeSat Automatic Identification System Receiver	Achmad Munir, Nazmi Febrian, Antrisha Daneraici Setiawan, Chairunnisa
7	TRF-08	Coupling Analysis of Isotropic and Anisotropic Dielectric Materials in Rectangular Waveguide	Muhammad Reza Hidayat, Achmad Munir
8	TRF-09	Effect of Element Number of SRR - based BPF to Its Characteristics	Mohammad Syahrul, Achmad Munir
9	TRF-10	Methods of MIMO Decoders for Very High Throughput WLAN IEEE802.11ac	Wahyul Amien Syafei, Zuhrotul Maulida, Imam Santoso
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RESEARCH ON POSITIVE NARROW BIPOLAR EVENTS IN PADANG

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Abstract— In this study, we have examined electric field records from 10 thunderstorm days containing 13 positive narrow bipolar pulses (PNBPs). It was found that PNPB occurrences have a strong relationship with thunderstorm activities. The mechanism of the NBP was very different from intracloud (IC) and cloud-to-ground (CG) flashes. We also found that the AM values of rise time, full width at maximum time, zero crossing time, overshoot time, pulse duration and overshoot to peak amplitude ratio of the PNBPs were 1.64 μ s, 1.32 μ s, 9.38 μ s, 15.06 μ s and 0.31 μ s, respectively. The pulse duration range was from 8.45 to 29.06 μ s. Comparison with values from previous studies reported by other researchers showed that the mentioned parameters had no strong relationship with latitude or geographic location.

Keywords—*narrow bipolar pulse; cloud flash; ground flash; thunderstorm; lightning*

I. INTRODUCTION

Narrow bipolar pulses (NBPs) are identified as one of the intracloud (IC) lightning discharge activities inside thunderclouds. However, the physical mechanism of NBPs remains a mystery. Many researchers have reported that there were two types of NBPs, namely positive narrow bipolar pulses (PNBP) and negative narrow bipolar pulses (NNBP). NBPs have strong radio frequency radiation at several MHz and a short duration with zero crossing (initial positive half cycle) and overshoot (negative half cycle) within several microseconds, followed by or not followed by any other signals [1-4]. NBPs may not be related to ground and cloud flash activities and originate inside the most active thundercloud areas [2]. PNBPs usually occur at lower latitudes than NNBP events [5]. This study is to clarify the relationship between thunderstorm activity and PNPB occurrence. We examined an electric field change data set with 13 PNBPs that were recorded during thunderstorm days in 2015. The characteristics of the PNBPs were statistically analyzed based on electric field change as presented in this paper. All data were also compared to previous researches at different locations and latitudes.

II. OBSERVATION AND DATA

The electric field records containing the PNBPs presented here were recorded from January to December 2015 in Padang, Indonesia (0° N) on 10 thunderstorm days using an electric field mill and a broadband electric field fast antenna. Both electric field sensors on the rooftop of the Electrical Engineering Department Building of Andalas University were located at 13 km from Padang Beach, Indian Ocean at an altitude of 317 m above sea level. The fast antenna with parallel flat-plate configuration was used to detect electric field changes in the thunderclouds. The fast antenna was connected to an amplifier and integrator with a time constant of 100 ms. Furthermore, all signals sensed by this antenna were recorded by a digitizer with a sample rate in the range of 1-4 MS/s and a record length of 250 ns - 1 s. To ensure that the strong electric field of lightning was recorded, the digitizer was set to window trigger mode at a trigger level of 1 V and a pretrigger time of 30% of the record length. The electric field measurement system used was similar to the one used in Hazmi et al. [6-7].

III. RESULTS AND DISCUSSION

In this study, 13 PNPB occurrences were analyzed. A summary of the PNPB events can be seen in Table 1. There are two types of PNPB events; for convenience, type A is called isolated PNPB to indicate that there are no other IC lightning occurrences, while type B is called non isolated PNPB which indicates that the occurrences are preceded or followed by other IC lightning occurrences, as displayed in Figures 1 and 2. The occurrence percentage of type A (46%) was slightly smaller than that of type B (54%). From Table 1, the PNBPs occurred during day and night time with the duration of the thunderstorms varying from 126 to 844 minutes. The background electric field changes of the thunderstorms recorded by an electric field mill sensor for negative and positive polarities varied between 0.284-4.096 kV/m and 0.364-4.094 kV/m, respectively. This indicates that the PNBPs occurred inside the most active thundercloud areas with high electric field. Our observation results were a good agreement with observation of Smith et al. [2]. However, PNBPs also occurred when the thunderstorms detected had a lower electric field, for example thunderstorm numbers 8 and 11 in Table 2. This may be due to the different distance between the PNBPs

TABLE 1. SUMMARY OF 10 THUNDERSTORM DAYS RECORDED IN PADANG FROM JANUARY TO DECEMBER 2015.

No	File Name	Date dd/mm/yy	Local Time (hh:mm:ss)	Type	Thunderstorm in 24 hours		
					Duration (min)	Maximum E-field polarity (kV/m)	
						Negative	Positive
1	20140526-0001 (25369)	30/01/2015	6:21:51	A	126	-4.096	4.094
2	20140526-0001 (25370)	30/01/2015	6:22:45	B			
3	20140526-0001 (25539)	05/02/2015	19:10:27	A	636	-3.668	3.368
4	20140526-0001 (25554)	05/02/2015	19:33:55	B			
5	20140526-0001 (25573)	16/02/2015	12:55:38	B	150	-4.096	2.926
6	20140526-0001 (26674)	08/03/2015	2:27:38	B	192	-1.668	2.756
7	20140526-0001 (27162)	14/03/2015	22:18:17	B	436	-4.096	4.094
8	20140526-0001 (27299)	18/03/2015	19:54:53	B	844	-0.284	0.364
9	20140526-0001 (28048)	24/03/2015	22:32:12	A	678	-4.096	3.874
10	20140526-0001 (30179)	10/04/2015	15:47:19	B	802	-3.202	2.228
11	20140526-0001 (30226)	15/04/2015	1:07:08	A	561	-1.378	1.856
12	20140526-0001 (31524)	11/12/2015	19:11:39	A	642	-4.096	4.094
13	20140526-0001 (31527)	11/12/2015	19:20:42	A			

and the electric field mill sensor. The more distant the measurement, the smaller the electric field magnitude recorded by the electric field mill sensor. We did not find that any of the PNBPs events were accompanied by CG flash events. Thus, there is not strong relationship between PNBPs, IC and CG flash occurrence.

The physics sign convention was used to examine the electric field changes in this study. An expanded PNBPs is shown in Figure 3. In addition, the studied parameters in this research were full width at maximum time (0-100%), rise time (10-90%), zero crossing time, overshoot time, pulse duration and overshoot to peak amplitude ratio, as shown in Figure 3. The characteristics of the PNBPs are summarized in Table 2.

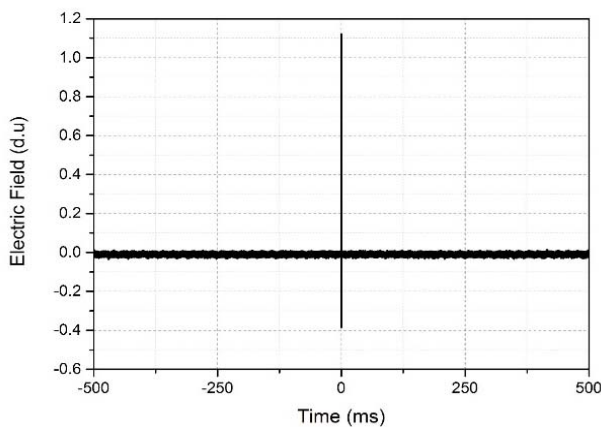


Fig. 1. A typical isolated PNBPs E-field waveform.

The full width at maximum time (T_{r1}) is the time interval that relates to the values of 0% and 100% of the peak

amplitude of the signal. This parameter is important to measure the initial transient signal of a PNBPs. The minimum, maximum, arithmetic mean (AM) and geometric mean (GM) values of the full width at maximum time were $3.24 \pm 1.20 \mu\text{s}$, $3 \mu\text{s}$, respectively.

The rise time (T_{r2}) is the time interval that relates to the values of 10% and 90% of the peak amplitude signal. The AM and GM values of PNBPs rise time were $1.64 \pm 0.51 \mu\text{s}$ and $1.56 \mu\text{s}$, respectively, with minimum and maximum values of $0.89 \mu\text{s}$ and $2.65 \mu\text{s}$, respectively. Comparing these values to those from other researchers, our AM value was smaller than that of Karunaratne et al. [8], Ahmad et al. [9] and Sharma et al. [10]. Their results were $2.6 \mu\text{s}$, $2.7 \mu\text{s}$ and $2.6 \mu\text{s}$, respectively. However, our AM value was larger than that of Medelius et al. [11] and Gunasekara et al. [12] with obtained results of $1.54 \mu\text{s}$ and $1.38 \mu\text{s}$, respectively. The difference may be due to data limitations in this study.

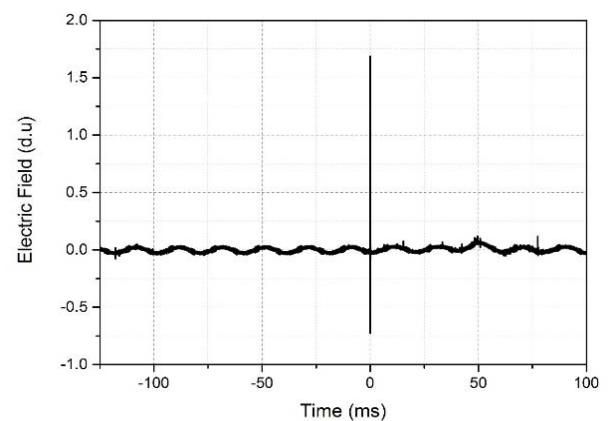


Fig. 2. A typical non isolated PNBPs E-field waveform.

The zero crossing time (T_z) is defined as the time difference from the first zero point to the next zero point, represented by zero crossing of the signal. The zero crossing time varied from 3.72 to 7.03 μs with AM and GM values of $5.23 \pm 1.14 \mu\text{s}$ and 5.11 μs . The AM values from previous studies in other latitudes, as reported by Gunasekara et al. [12], Karunarathne et al. [8], Nag et al. [13], Ahmad et al. [9], Sharma et al. [10] and Cooray and Lundquist [14], were 4.66 μs , 9.9 μs , 5.6 μs , 6.5 μs , 5.78 μs , and 13 μs , respectively. The zero crossing time at the same latitude had different values as reported by Gunasekara et al. [12] and Sharma et al. [10]. It was clear that the AM value did not depend on latitude.

The overshoot time (T_o) is the time interval between the first zero crossing point and the end signal to reach the next zero crossing point. It varied from 3.71 to 25.23 μs . The mean value was $9.38 \pm 6.55 \mu\text{s}$ with a GM value of 8.01 μs .

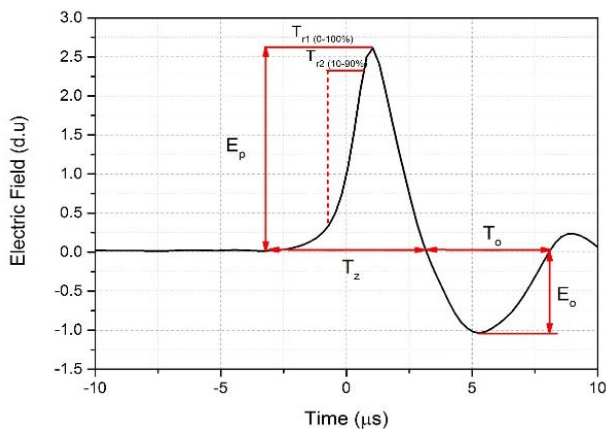


Fig. 3. The expanded narrow bipolar pulse E-field waveform.

The pulse duration is the total time interval that corresponds to the positive half cycle and the negative half cycle (overshoot) of the signal. It had an AM value of $15.06 \pm 6.38 \mu\text{s}$ and a GM value of 13.90 μs , while it ranged from 8.45 to 29.06 μs . The AM values from other researchers, i.e. Gunasekara et al. [12], Nag et al. [13], Ahmad et al. [9], Sharma et al. [10] and Cooray and Lundquist [14], were 16.42 μs , 23 μs , 30.2 μs , 13.3 μs , and 75 μs , respectively. It was found that the AM value did not depend on latitude. The different results may be due to the specific characteristics of the electric field sensor system and thunderstorm type.

TABLE 2. SUMMARY OF OBSERVED PNBP PARAMETERS.

Parameters	Min	Max	AM	GM
Rise time (10-90%) (μs)	0.89	2.65	1.64 ± 0.51	1.56
Full width at max (0-100%) (μs)	1.51	5.00	3.24 ± 1.20	3.00
Zero crossing time (T_z) (μs)	3.72	7.03	5.23 ± 1.14	5.11
Overshoot time (T_o) (μs)	3.71	25.23	9.83 ± 6.55	8.01
Pulse duration (μs)	8.45	29.06	15.06 ± 6.38	13.90
Amplitude ratio (E_o/E_p)	0.17	0.41	0.31 ± 0.07	0.30

The overshoot (E_o) to peak amplitude (E_p) ratio is determined by comparing peak overshoot to initial peak of

signal amplitude. The minimum, maximum, standard deviation, AM and GM values of this ratio were 0.17 μs , 0.41 μs , 0.07 μs , 0.31 μs and 0.30 μs . The results from previous researches, as reported by Gunasekara et al. [12], Nag et al. [13], Ahmad et al. [9], Sharma et al. [10] and Cooray and Lundquist [14], were 0.37 μs , 0.17 μs , 0.27 μs , 0.35 μs , and 0.30 μs , respectively. Our mean value showed was the same as in previous researches, except from Nag et al. [13]. We predict that the difference in this parameter was influenced by differences in season and charge distribution of the thunderstorms.

IV. CONCLUSION

10 thunderstorm days containing 13 PNBPs were examined based on electric field records. The thunderstorm activities did not always cause PNB events. However, it was found that the PNB occurrences had a strong relationship with thunderstorm activities. The PNB mechanism is very different from IC and CG flashes. From our observations, the AM value of rise time, full width of maximum time, zero crossing time, overshoot, pulse duration and overshoot to peak amplitude ratio of PNBPs were 1.64 μs , 1.32 μs , 9.38 μs , 15.06 μs and 0.31 μs , respectively. Comparison with previous studies, as reported by other researchers, suggests that the mentioned parameters do not depend on latitude or geographic location. The differences may be due to differences in thunderstorm types, seasonal conditions and instrumentation system characteristics. Further research is needed to gain a better understanding of the physical mechanism of narrow bipolar events (NBE).

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